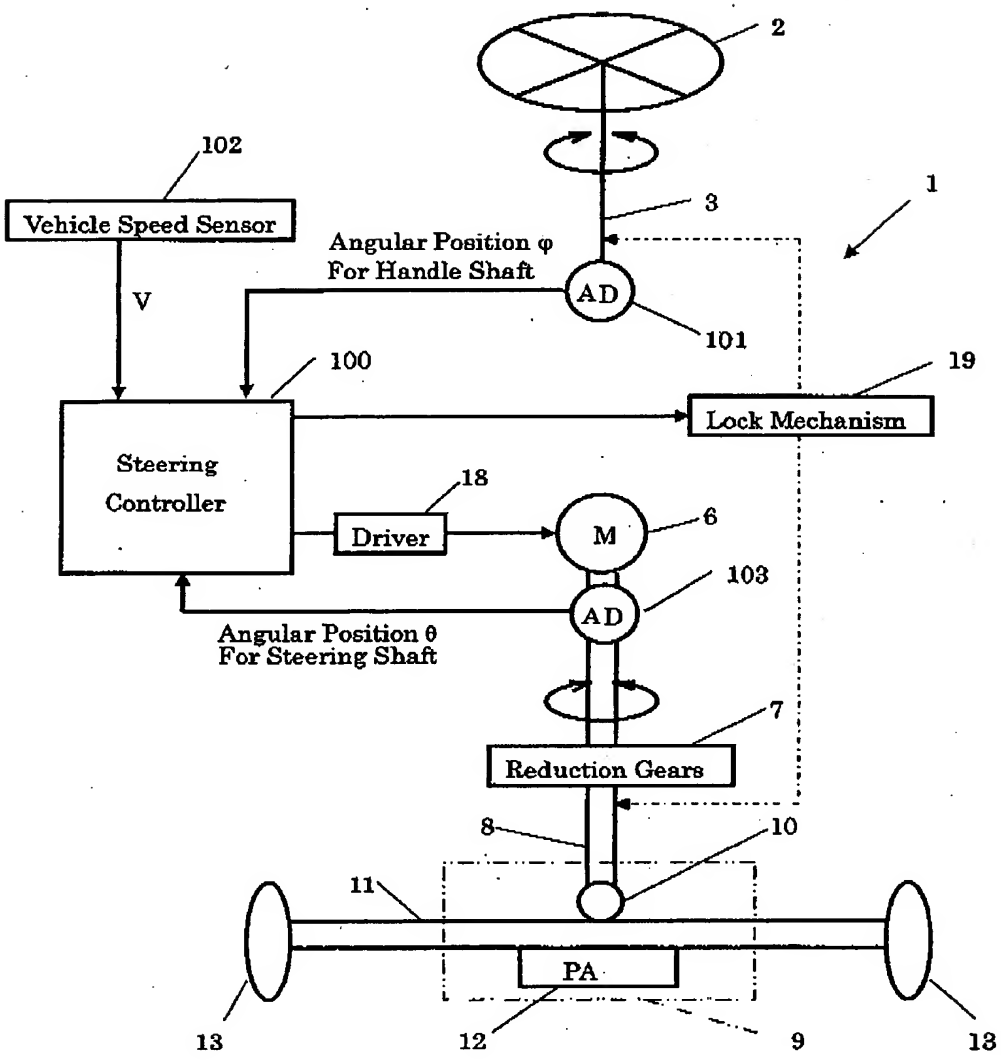
2
102
Vehicle Speed Sensor
1
3
Angular Position φ
For Handle Shaft
V
AD
101
100
19
Lock Mechanism
Steering
Controller
18
Driver
M
6
103
AD
Angular Position θ
For Steering Shaft
7
Reduction Gears
8
10
11
PA
13
12
9
13

FIG. 1

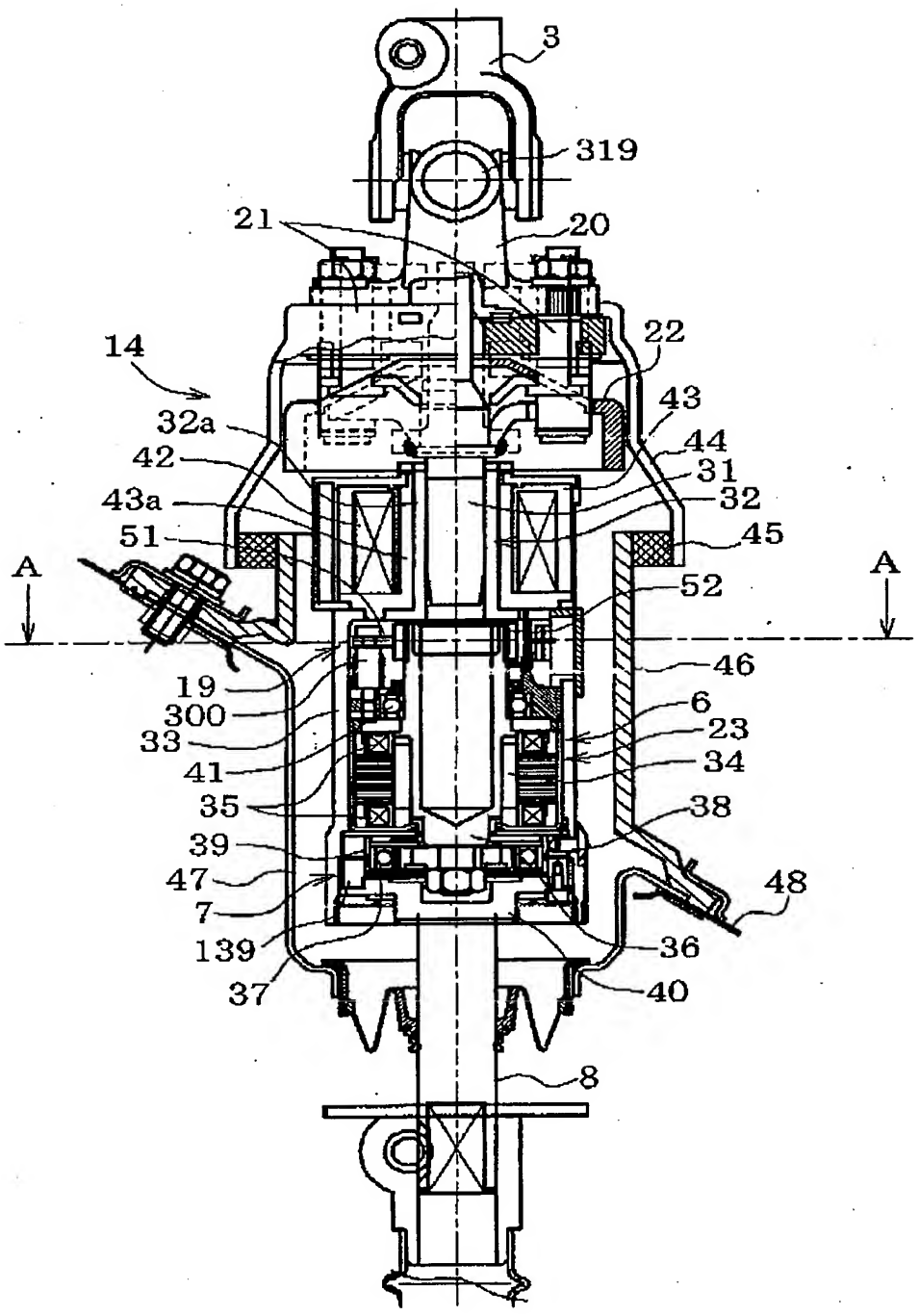
3
319
21
20
22
14
43
32a
44
42
31
43a
32
51
45
A
A
52
46
19
6
300
23
33
34
41
35
38
39
47
48
7
139
36
37
40
8

FIG. 2

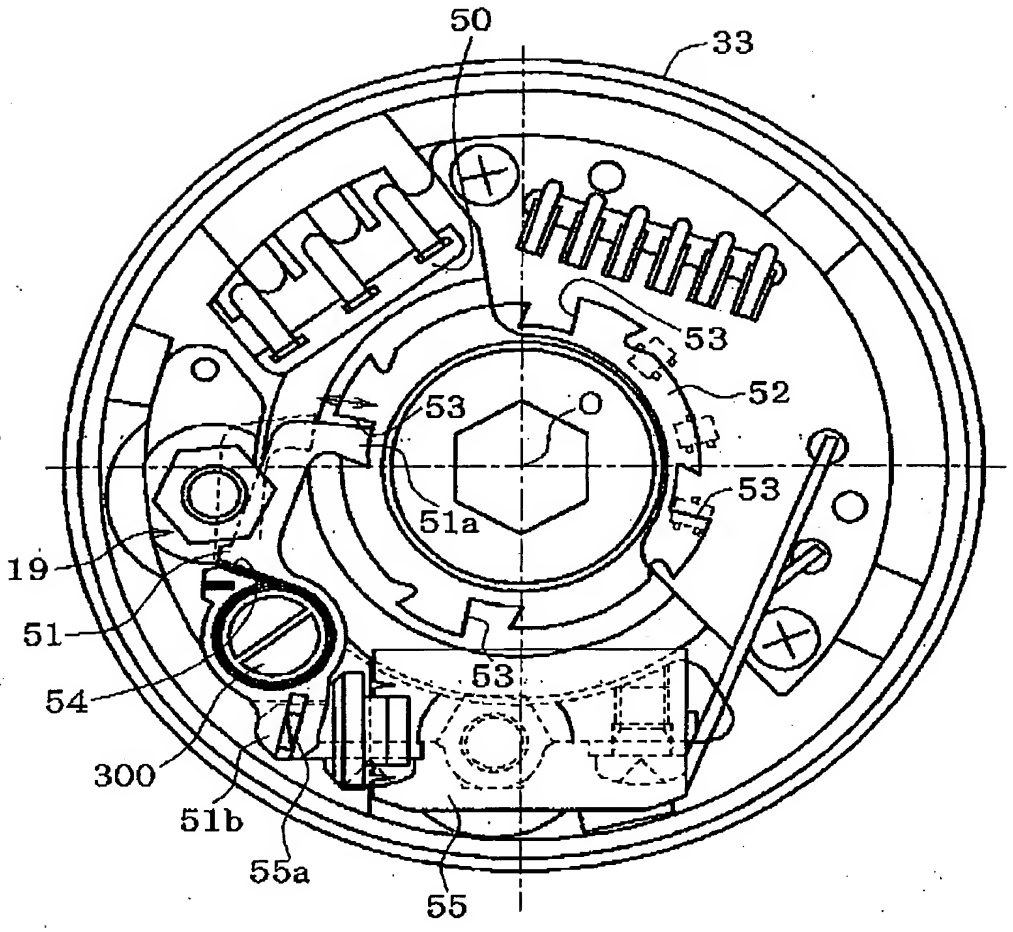

FIG. 3

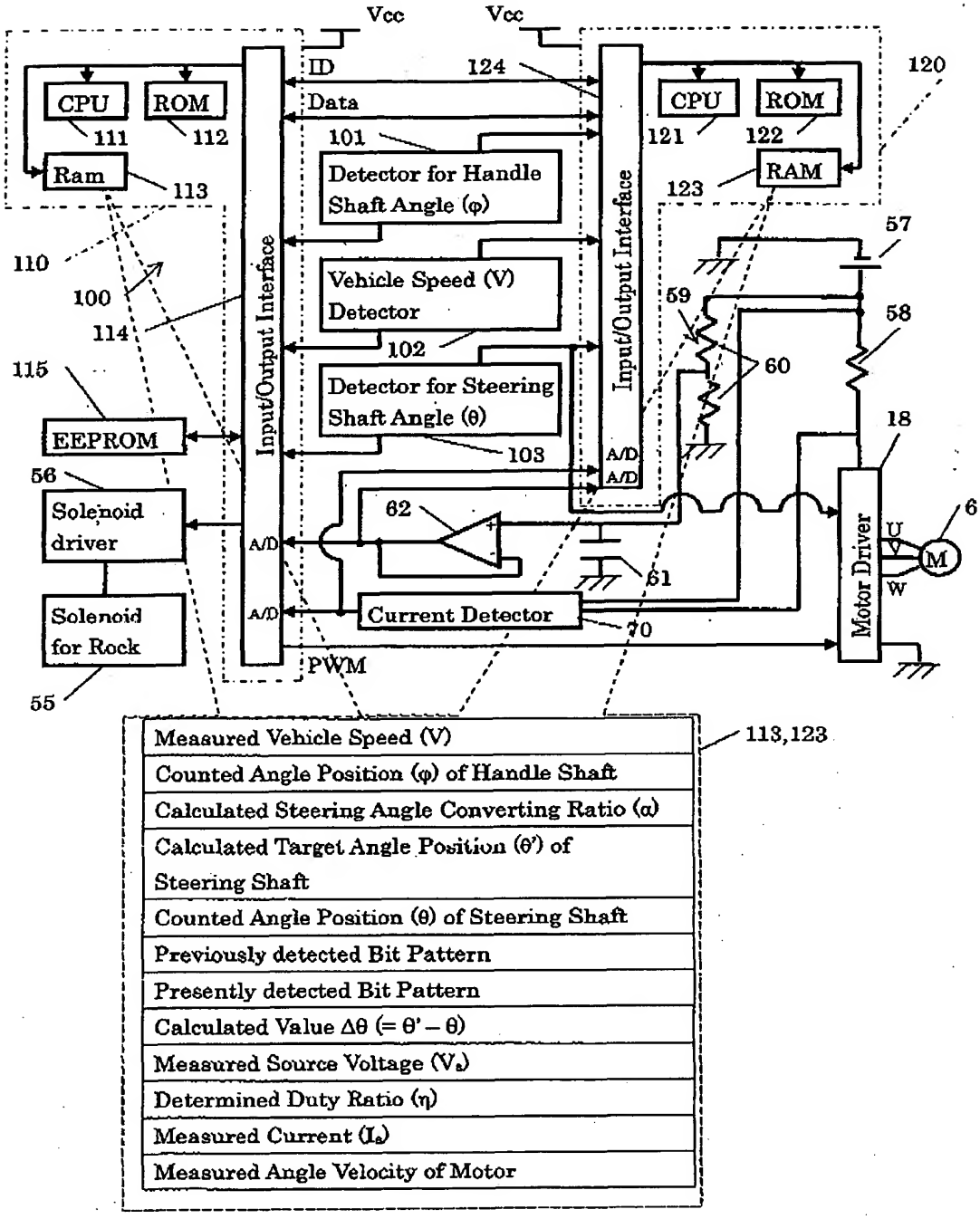
Vcc
Vcc
CPU
ROM
111
112
Ram
113
110
100
114
115
EEPROM
56
Solenoid driver
Solenoid for Rock
55
Input/Output Interface
ID
Data
PWM
A/D
A/D
101
Detector for Handle Shaft Angle (φ)
Vehicle Speed (V) Detector
102
Detector for Steering Shaft Angle (θ)
103
62
Current Detector
70
124
Input/Output Interface
A/D
A/D
120
CPU
ROM
121
122
RAM
123
57
59
58
60
18
61
Motor Driver
U
V
W
M
6
Measured Vehicle Speed (V)
Counted Angle Position (φ) of Handle Shaft
Calculated Steering Angle Converting Ratio (α)
Calculated Target Angle Position (θ') of Steering Shaft
Counted Angle Position (θ) of Steering Shaft
Previously detected Bit Pattern
Presently detected Bit Pattern
Calculated Value Δθ (= θ' – θ)
Measured Source Voltage (Vb)
Determined Duty Ratio (η)
Measured Current (Ib)
Measured Angle Velocity of Motor
113,123

FIG. 4

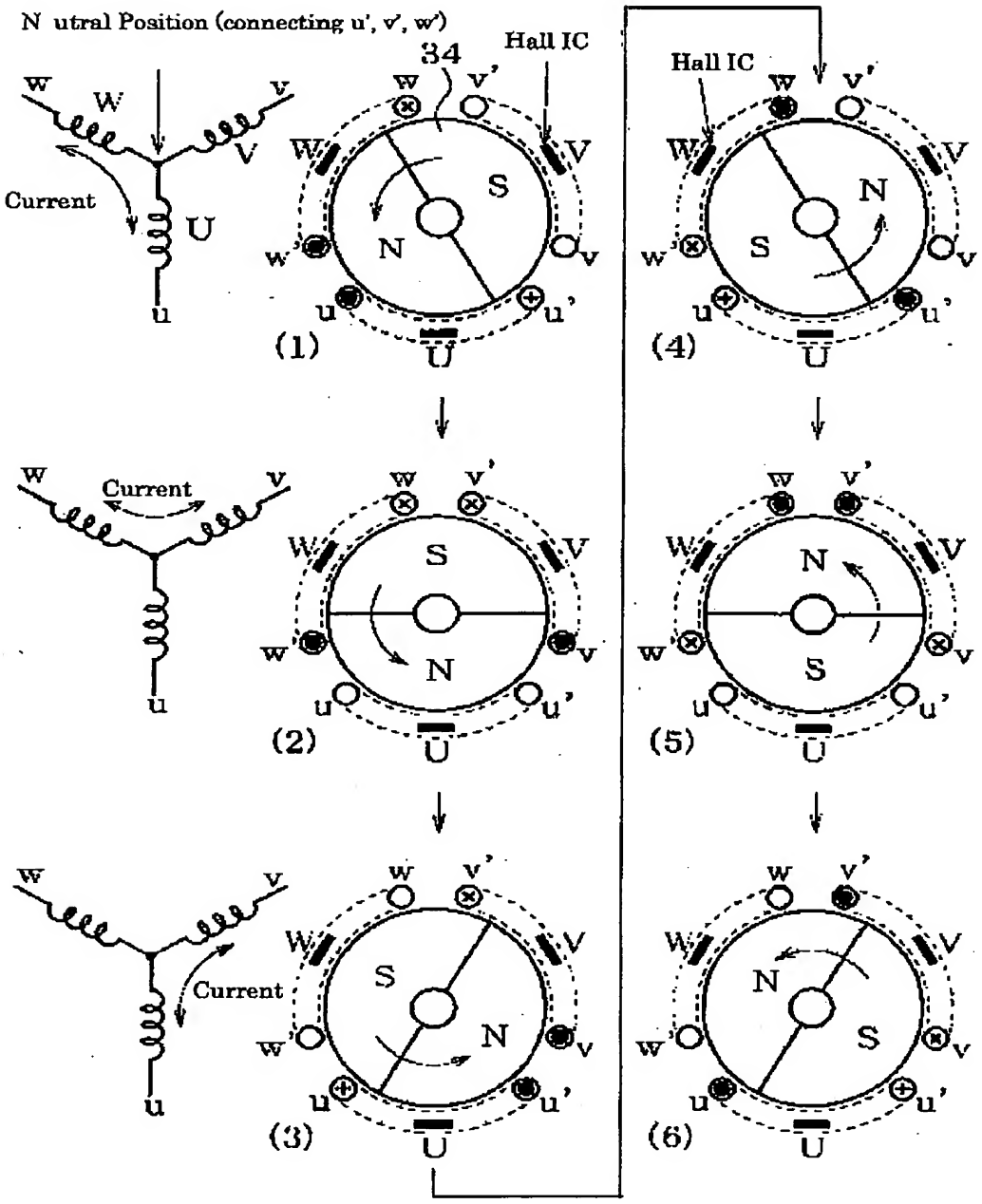
N utral Position (connecting u', v', w')
Hall IC
34
Current
W
V
U
u
w
v
u'
S
N
(1)
(2)
(3)
(4)
(5)
(6)

FIG. 5

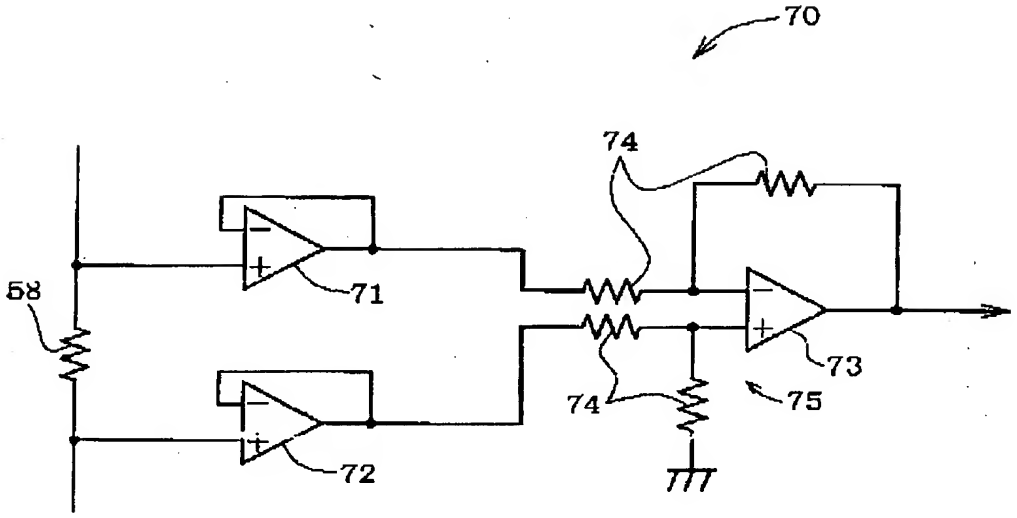
70
74
58
71
73
74
75
72

FIG. 6

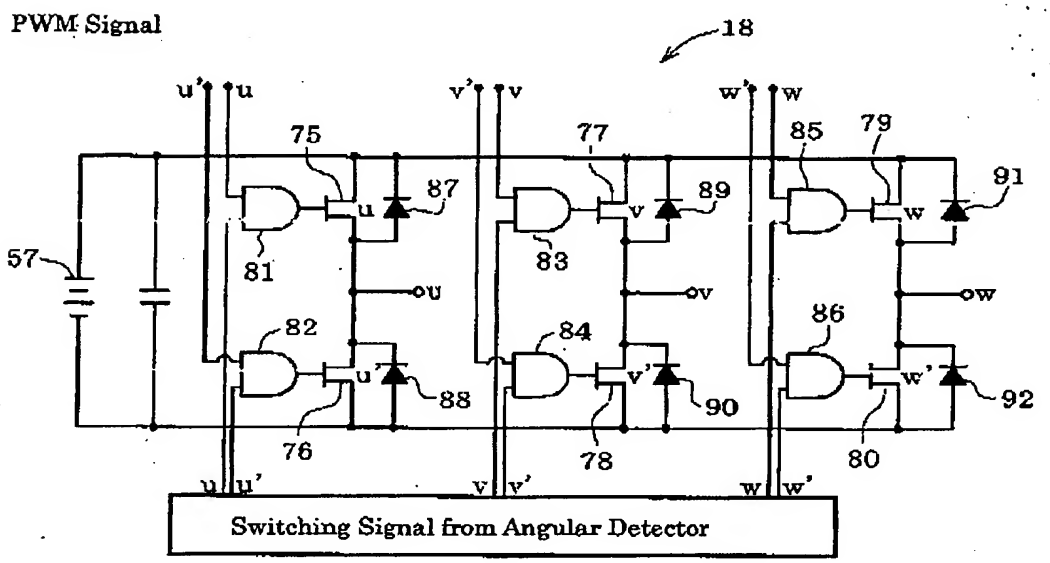
PWM Signal
18
u'
u
v'
v
w'
w
75
77
85
79
91
87
89
57
81
83
ou
ov
ow
82
84
86
u'
v'
w'
88
90
92
76
78
80
u
u'
v
v'
w
w'
Switching Signal from Angular Detector

FIG. 7

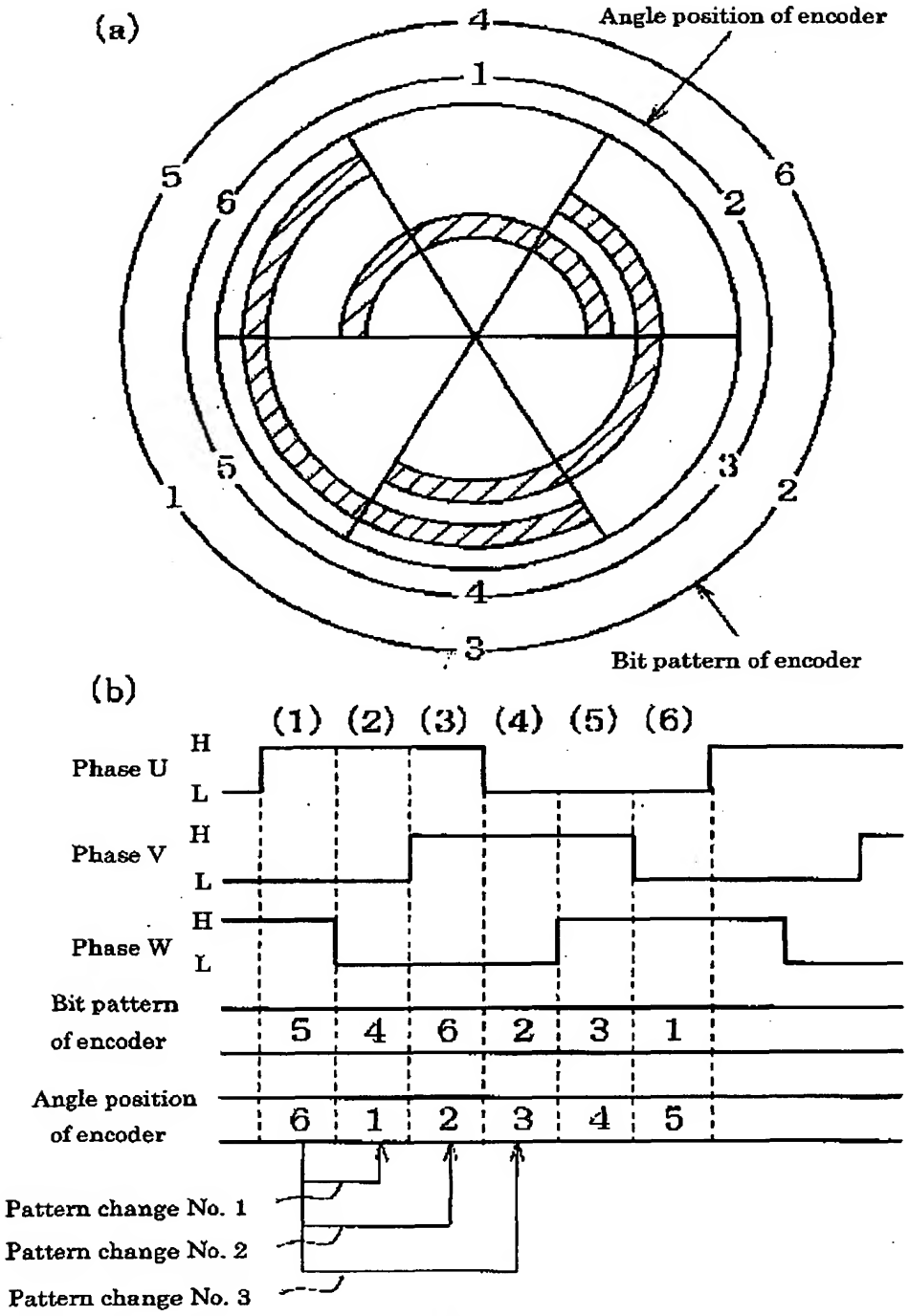
(a)
Angle position of encoder
Bit pattern of encoder
(b)
(1) (2) (3) (4) (5) (6)
Phase U
Phase V
Phase W
H
L
Bit pattern of encoder
5 4 6 2 3 1
Angle position of encoder
6 1 2 3 4 5
Pattern change No. 1
Pattern change No. 2
Pattern change No. 3

FIG. 8

130

Vehicle Speed (V)	V_1	V_2	V_3	.....	V_n
Steering Angle Exchanging Ratio (α)	α_1	α_2	α_3		α_n

$\alpha=\theta/\varphi$ φ: Angular position of handle shaft

θ: Angular position of steering shaft

FIG. 9

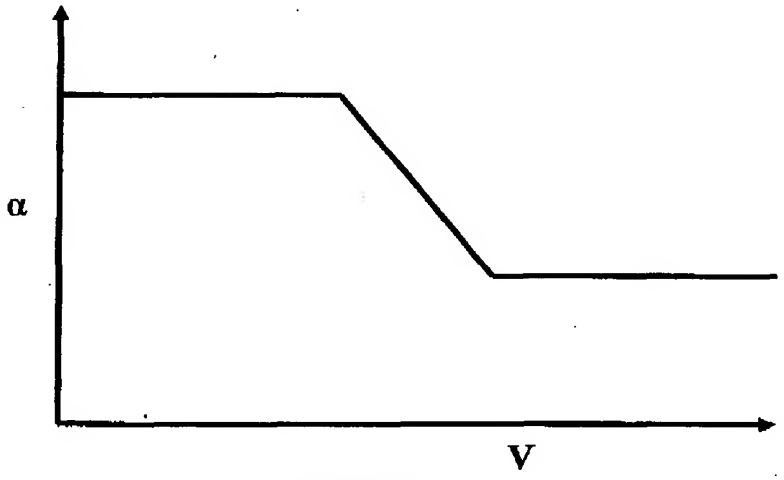

FIG. 10

131

$\Delta\theta$ \ V_s	V_{s1}	V_{s2}	V_{s3}	V_{s4}	.....	V_{sn}
$\Delta\theta_1$	η_{11}	η_{12}	η_{13}	η_{14}	.....	H_{1n}
$\Delta\theta_2$	η_{21}	η_{22}	η_{23}	η_{24}	.....	H_{2n}
$\Delta\theta_3$	η_{31}	η_{32}	η_{33}	η_{34}	.....	H_{3n}
$\Delta\theta_4$	η_{41}	η_{42}	η_{43}	η_{44}	.....	H_{4n}
....	....	....	....	....	.....	....
$\Delta\theta_m$	η_{m1}	η_{m2}	η_{m3}	η_{m4}	.....	η_{mn}

η: Duty Ratio θ': Target angular position of steering shaft

$\Delta\theta = \theta' - \theta$ θ : Present angular position of steering shaft

FIG. 11

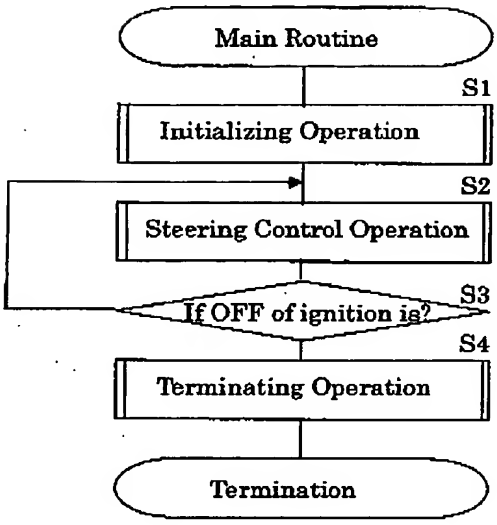
Main Routine
S1
Initializing Operation
S2
Steering Control Operation
S3
If OFF of ignition is?
S4
Terminating Operation
Termination

FIG. 12

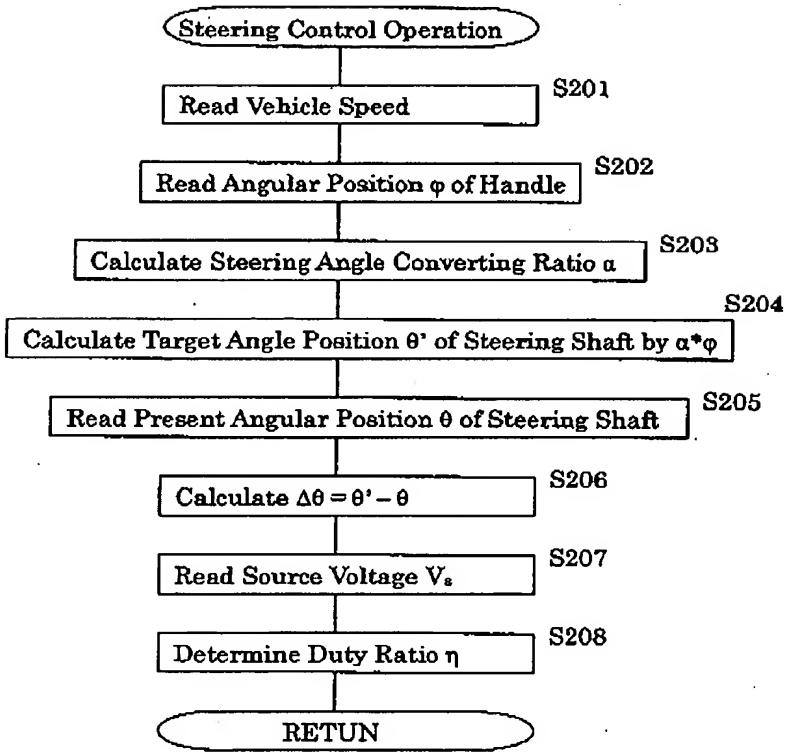
Steering Control Operation
Read Vehicle Speed
S201
Read Angular Position φ of Handle
S202
Calculate Steering Angle Converting Ratio α
S203
Calculate Target Angle Position θ' of Steering Shaft by α*φ
S204
Read Present Angular Position θ of Steering Shaft
S205
Calculate Δθ = θ' − θ
S206
Read Source Voltage Vs
S207
Determine Duty Ratio η
S208
RETUN

FIG. 13

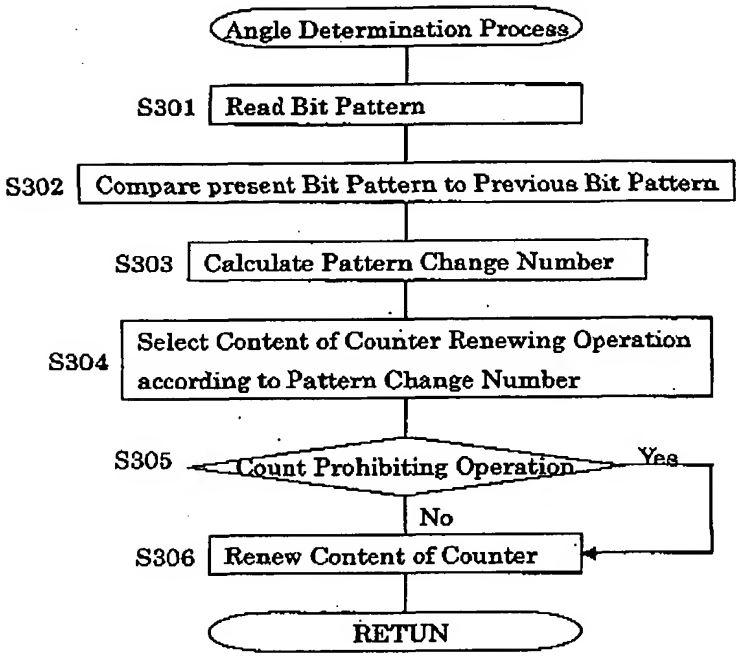
Angle Determination Process
S301
Read Bit Pattern
S302
Compare present Bit Pattern to Previous Bit Pattern
S303
Calculate Pattern Change Number
S304
Select Content of Counter Renewing Operation according to Pattern Change Number
S305
Count Prohibiting Operation
Yes
No
S306
Renew Content of Counter
RETUN

FIG. 14